

OCCASIONAL PAPERS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

No. 33, 7 pages, 4 figures.

December 31, 1961

NOTES ON THE HORNSHARK,
HETERODONTUS FRANCISCI, WITH
OBSERVATIONS ON MATING ACTIVITIES

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Mating activities among sharks are seldom observed, and as a result detailed descriptions of courtship and nuptial patterns are available for only a few species. Much controversy has developed through the years as to whether the male shark uses two claspers in copulation or whether only one clasper, and if only one clasper whether right-handedness and left-handedness is involved. It is known that some sharks follow the pattern of the European common dogfish, *Scyliorhinus canicula*, in which the male loops his body around the female and uses a single clasper¹ or is occasionally thought to use both claspers. But there are others, such as the hornshark described herein, that always follow the single-right-clasper technique.

Interest in this problem by the Steinhart Aquarium staff was initiated by an event which occurred on December 30, 1949. A worried visitor reported a "terrific fight" taking place between two hornsharks in one of the large display tanks. One fish was about to kill another and "something should be done to prevent this tragedy." A quick check of the 1043-gallon tank revealed that the "lethal battle" was actually mating and courtship. The pair were average in size, and the male, measuring $27\frac{1}{2}$ inches, had seized a $28\frac{1}{2}$ inch

¹ Photographed by Dr. D. P. Wilson and published in *The Open Sea: Fish and Fisheries*, by Sir Alister Hardy, pl. 15, 1959, Houghton Mifflin.

female by the left pectoral fin and was firmly holding on to it with his mouth. The female was lying partially on her left side facing the male and did not appear to be making any great effort to get away from him. In a short time he had manipulated his body so that his tail occupied a position over her back immediately in front of the second dorsal fin. By using her second dorsal spine as an anchor and, at the same time, holding on to the left pectoral fin with his mouth -- the mid-region of his body being in a position to move freely -- he was able to thrust his right clasper into her vent. The left clasper played no part whatsoever in the sexual act; it hung loosely in the water (fig. 1). A garibaldi (*Hypsypops rubicunda*) in the same tank was attracted by this unused clasper and from time to time nipped at it. The hornshark paid no attention to the garibaldi's harassing activity. Throughout the entire time of copulation (35 minutes), a gentle rhythmic motion was observed in the caudal region of the male and the female lay motionless on her side.

During the few weeks following this observation the same male hornshark (there were two others in the tank) was often seen chasing other females. Once he seized a female by the gill area. During the time he held her, she acted as if she were paralyzed and made no attempt to get away. The gills in the region he was biting appeared to be nonfunctional during the time he had his mouth on the folds of skin covering them. The gills on the opposite side of the body were not affected by this and were functioning quite normally. After a few minutes he released her and showed no further courtship or mating activity. The female, however, at frequent intervals would turn over and over and spin with her nose in the sand as though she had lost all sense of equilibrium. Several visitors watching her peculiar behavior pattern remarked that obviously the poor fish was most certainly in its death throes and should be put out of its misery. But in about half an hour, she had returned to normal.

Hornshark eggs (fig. 2) laid in the tanks at Steinhart Aquarium have never hatched, although attempts to hatch them have been made each spring for at least ten years. The length of egg incubation within the female of *Heterodontus francisci* is not known with certainty; however the first observed mating at Steinhart during 1960 occurred on February 12 and the first eggs in the tank appeared March 19, which is an elapsed time of 37 days. That this time may be of shorter duration is indicated by observations made at the T. Wayland Vaughan Aquarium at the Scripps Institution of Oceanography, La Jolla, California.² One of their female hornsharks laid two eggs about two weeks after copulation. The eggs hatched at unrecorded dates between eight and ten months later; the newly-emerged hornsharks measured approximately seven inches, and lived for only a few months.

The extruded egg case of the hornshark measures about five inches in length and $2\frac{1}{2}$ inches in width. It is an elongated, cone-shaped capsule with

² Verbal communication from Mr. Sam Hinton.

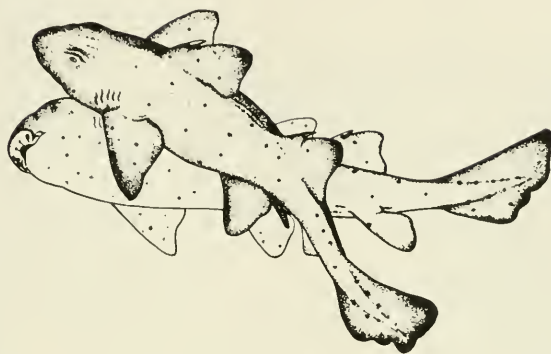


Fig. 1. Sketch of copulatory position of Pacific hornsharks, *Heterodontus francisci*.



Fig. 2. Egg case of Pacific hornshark, *Heterodontus francisci*. (Photograph by Richard Brace.)

very thick walls of keratin; two broad, flat flanges twist spirally around it. When the egg cases are first laid (February and March) they are pellucid and light brown in color, but after being in the water for a few days, they become darker and more or less opaque.

On one occasion a peculiar belligerency towards newly-laid eggs was demonstrated by an adult female hornshark who picked up one of the eggs and carried it about the tank for some five minutes. Finally getting a good bite on the egg case, she squeezed it like a toothpaste container, forcefully extruding all of the egg material. Unfortunately there was no way to determine if this was the same female which had laid the eggs, or another individual.

Whitley (1950:28) has described the development of a crested Port Jackson shark, *Heterodontus galeatus* (Günther). His observations are based on a shark that hatched from an egg thought to have been laid in July, 1937, and subsequently brought to the Taronga Park Aquarium in Sydney, Australia, on August 15, 1937. Measurements of the embryo were taken a few months before it hatched; at six months it was about 2½ inches and at seven months, some 4 inches. Hatching took place on April 5, 1938, after an incubation period of about eight months. The newly-hatched shark measured 6¾ inches in total length. Its growth is detailed in table 1. At age 11 years 8 months it began laying eggs. Six eggs were laid within a period of ten days, but unfortunately this shark was alone in the tank, so the eggs were infertile.

The hornshark takes its name from the heavy spine found at the forward edge of each of the two dorsal fins. It has a piglike face and in the mouth are large dental plates covered with many small and usually sharp teeth (fig. 3). All of the approximately 8 to 10 species are small sedentary bottom sharks found in shallow tropical and temperate marine waters from Africa to the Pacific American coasts. They are not found in the Atlantic or Mediterranean. The species are usually assigned to the single genus *Heterodontus* and given a separate family by themselves, the Heterodontidae. Although the California hornshark reaches a length of four feet, a few of the other species grow to five feet, the maximum size for the family.

In addition to the California hornshark, we have also kept the Australian *Heterodontus portusjacksoni* for a number of years. In captivity these species are similar in their habits, and it is probable that their activities are much the same as are those of the remaining species in the family. Much of the time they lie motionless in one corner of the tank.

In the aquarium they seem to prefer a sandy bottom and often hide behind large rocks or other objects that may be present in the tank. The late Conrad Limbaugh, noted diving ichthyologist, studied the hornshark throughout most of its range from central California to Cape San Lucas and the Gulf of California; he reported (1955: 50-51): "hornsharks live among rocks in the shallower water, usually with the head in a crevice. They were observed at depths averaging 18 feet but ranging from shallow tidepools to 55 feet, with most of



Fig. 3. Front head view of the Pacific hornshark, *Heterodontus francisci*. (Photograph by Richard Brace.)

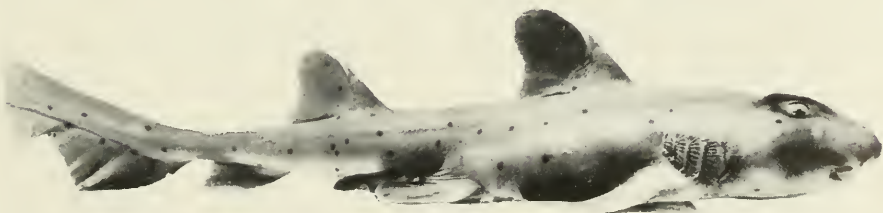


Fig. 4. Lateral view of Pacific hornshark, *Heterodontus francisci*. (Photograph by Richard Brace.)

TABLE 1
 Growth of *Heterodontus galeatus*
 From Whitley (1950)

	Increment (inches)	Length (inches)	Weight (pounds)
Hatching	--	$6\frac{3}{4}$	--
1st Year	2	$8\frac{3}{4}$	--
2nd Year	2	$10\frac{3}{4}$	--
3rd Year	3	$13\frac{3}{4}$	--
4th Year	$(2\frac{1}{8})$	$(15\frac{7}{8})$	--
5th Year	$(2\frac{1}{8})$	18	--
6th Year	$(2\frac{1}{8})$	$(20\frac{1}{8})$	--
7th Year	$(2\frac{1}{8})$	$22\frac{1}{4}$	6
8th Year	$\frac{3}{4}$	23	--
9th Year	$1\frac{1}{2}$	$24\frac{1}{2}$	6
10th Year	$1\frac{3}{4}$	$26\frac{1}{4}$	5 lb. 12 oz.
11 Years 10 months	$2\frac{1}{4}$	$28\frac{1}{2}$	$8\frac{1}{2}$

the population concentrated between 8 and 35 feet." The hornshark has also been caught at depths as great as 500 feet, and is suspected of migrating from shallow to deep water dependent upon the season (Roedel, 1953: 12).

Nature seems to have provided the hornshark with a highly developed sense of touch. If a net, brush, or other object is placed in the tank, the sharks are immediately aware of it and at once become so active that they may on occasion leap out of the water and wiggle over the sides of the tank unless precautions are taken to prevent this. For this reason, high tank walls or special side boards may be necessary to keep them in the tank.

Hornsharks are poor swimmers and may easily be caught by a skindiver, or in the aquarium they may be picked up by someone who happens to be standing near the tank as the animal swims near the surface.

These sharks seem to adjust readily to captivity, and to thrive on a routine aquarium diet of raw fish, horse heart, and beef liver. The California hornshark has lived for twelve years in captivity, and the Australian *Heterodontus galeatus* has also lived for twelve years at the Taronga Park Aquarium in Sydney.

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